

Original Research Article

## Evaluation of Role of MRI in Knee Joint Injuries in Correlation with Arthroscopy

Dr. Anil U Madurwar<sup>1</sup>, Dr. M. Ramya<sup>2</sup>, Dr. Sravan Kumar<sup>2</sup>, Dr. Bhavani<sup>2</sup>

<sup>1</sup>Professor, <sup>2</sup>Post Graduate,

Department of Radiodiagnosis, Chalmeda Ananda Rao Institute of Medical Sciences and Hospital, Karimnagar.

Corresponding Author: Dr. Anil U Madurwar

### ABSTRACT

**Aims and objectives:** To evaluate the role of MRI in knee joint injuries and correlating the MRI findings with arthroscopic or operative findings wherever performed.

**Study Design:** Prospective analytical study.

**Materials and methods:** MRI of 50 patients with 42 arthroscopic correlation during December 2014 to June 2016 was analyzed.

**Results:** Out of 50 patients 42 were males and 8 of them were females. The sensitivity, specificity, PPV and NPV was calculated (in %). For ACL it was 94.5,80,94.5,80, for PCL 100, for MM 68.42,86.66,76.47,81.2 and for LM 69.23,94.10,81.81,88.88 respectively

**Keywords:** MRI, knee joint, meniscus tears, cruciate ligament, arthroscopy.

### INTRODUCTION

Trauma to the knee may result in injury to the menisci, cartilage, ligaments or bone. Physical examination of the painful knee in the acute phase may be difficult and frequently imaging studies are required to aid in the assessment of these injuries. [1] Arthroscopy has a diagnostic accuracy of 64 to 94% but is an invasive procedure and is associated with complications. Anterior cruciate ligament (ACL) is commonly injured ligament in knee. [2] and usually associated with Meniscal injuries. [3] Kean et al., in 1980's used MRI in knee. [3] The accuracy of MRI is very high in diagnosing knee lesions and has a sensitivity of 80% to 100%. [4] MRI of the knee is currently the diagnostic procedure of choice for the diagnosis of injuries to the menisci, ligaments and tendons as well as bone bruises and occult fractures in the knee [5] and in most centers it has replaced arthrography and diagnostic arthroscopy. [7]

Failure to recognize and properly manage knee injuries can result in diminished lifestyle, time of work and premature osteoarthritis. Accurate assessment of the nature of these injuries is a prerequisite for appropriate therapy.

MRI is noninvasive, has proved reliable, safe and offers advantages over diagnostic arthroscopy, which is currently regarded as the reference standard for the diagnosis of internal derangements of knee. Arthroscopy is an invasive procedure with certain risks and discomfort to the patient. MRI provides superior anatomical and pathological definition of soft tissues, ligaments, fibrocartilage and articular cartilage. Fast spin echo and fat suppression MRI techniques have extended the sensitivity and specificity of MRI in the detection of articular cartilage, meniscal and cruciate ligament injuries.

MRI detects bone contusions, marrow changes, tibial plateau fractures.

MRI has unique ability to evaluate internal structure as well as the surface of the ligaments. The most significant advances in knee imaging have been made in MR imaging, which has clearly emerged as a primary tool, to guide the management of knee pain. With the development of new sequences, improved SNR, higher resolution, reduced artifacts, shorter imaging times and improved accuracy, MRI has changed the traditional algorithm for workup of meniscal and cruciate ligamentous tears. MRI has made it possible to look in to the injured knee noninvasively thereby avoiding invasive procedures and further morbidity.

## METHODOLOGY

### Patient and Methods:

A prospective study was conducted at the department of radiology in Chalmeda Ananda rao institute of medical sciences and hospital during the period December 2014 to June 2016. Fifty patients (50 knees) were examined, 42 patients were males and 11 patients were females their ages ranging from (16-61) years, presented with various knee joint injuries and were referred from Orthopedics Department in Chalmeda ananda rao institute of medical sciences and hospital.

**MRI examination: Instrument:** The examination done using 1.5 Tesla GE Signa HDxt scanner, with dedicated extremity coils (surface coils) as both transmitter and receiver of radio-frequency waves was applied. The imaging system is enclosed in a radio frequency room

**Inclusion Criteria:-** Patients of adult population(16-61years) willing to undergo MRI scanning with clinically suspected injuries of the knee and consenting for the same.

### Exclusion criteria

- All patients who present with pain and/swelling at the knee joint without any history of injury and inflammatory, degenerative, neoplastic, infective etiologies causing pain and/ swelling at knee joint are excluded from study.

Patients who had previously undergone arthroscopy with repair of menisci and ligaments.

- Patients not consenting for the study.
- Patients on cardiac pace maker.
- Patients on metal implants.
- Patients on neuro stimulators.

### Data Acquisition:-

Once a patient satisfied the inclusion criteria for this study, he or she was administered the study proforma. The patients were briefed about the procedure. The noise due to gradient coils (heard once the patient was inside the bore of the magnet) and the need to restrict body movements during the scan time was explained to the patient.

Patient is placed in supine position with the knee in a closely coupled extremity coil. The knee is externally rotated 15 – 20<sup>0</sup> (to facilitate visualization of the ACL completely on sagittal images) and is also flexed 5-10<sup>0</sup> (to increase the accuracy of assessing the patella-femoral compartment). MRI scan was done using saggital (T2 FSE, PDFAT SAT, STIR, T2 FRFSE fatsat) Coronal PD FATSAT and Axial STIR sequences using the standard imaging protocol.



Fig1:Sag PDFS image showing non visualisation of ACL - complete tear

### Image interpretation:

The ACL was evaluated on saggital, coronal & axial images and categorized as intact or torn. It was considered normal when a hypointense band like structure was seen. The presence of focal discontinuity or complete absence of ligament, abnormal

signal intensity of the ligament, wavy contour or poor definition of its ligamentous fibres were all considered as ACL tear [Fig-1]. A hypointense meniscus without any altered signal intensity was considered

normal. Presence of an intrameniscal high signal intensity was regarded as a tear and its grading was done according to whether it reaches to the articular surface or not [Fig-2a&b]

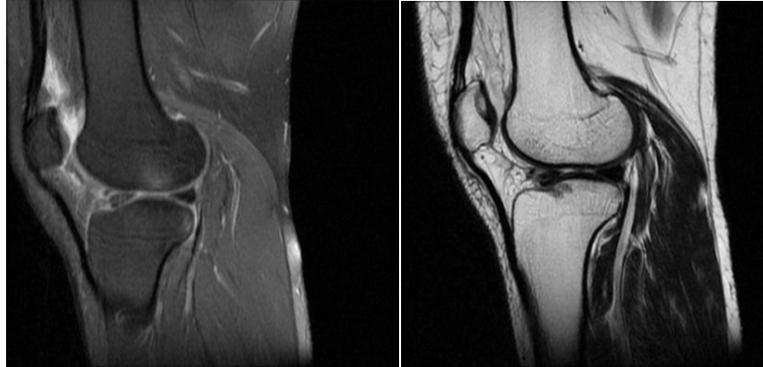


Fig 2a&b: Sag PDFS and Sag T2 images showing tear of anterior horn of medial meniscus

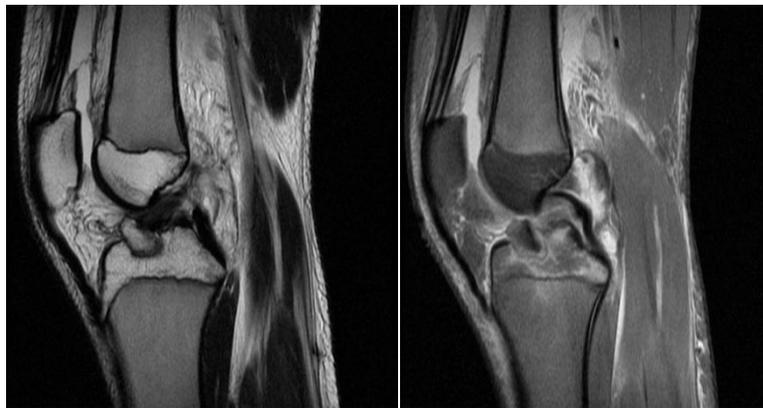


Fig 3a&b: Sag T2 and Sag PDFS images showing avulsion fracture of ACL at tibial attachment site and buckling of PCL

**Arthroscopic examination:** Arthroscopy is an operative technique to allow the visualization and ideal treatment of structures within the knee joint. It is most commonly performed under a short general anesthesia. The arthroscope is a fiberoptic instrument which is put into the knee joint

through two small incisions. A camera is attached to the arthroscope and the image is viewed on a T.V monitor. The arthroscope allows to fully evaluate the entire knee joint including the patella, the cartilage surfaces, the meniscus, the ligaments and the joint lining.

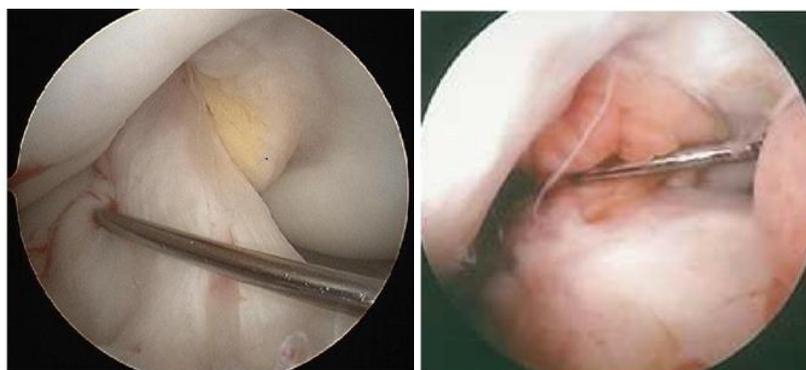


Fig 4: Arthroscopic images showing (a) Normal ACL (b) Torn ACL

## RESULTS

In our study MRI examination was performed on (50) patients with complaints of knee injury. Regarding the most common age group affected was the age group of (21-39) and this is explained by the fact that this age group being the most active group. From (50) patients examined in this study, 42 patients (76%) were males and 8 of them were females. Of them 36(76%) had ACL tears, 3 (6%) had PCL tears, 17(34%) had MM tears and 11(22%) had LM injuries as shown in (table 1)

**Table 1: Various injuries in knee joint trauma in study population**

TYPE OF TEAR	NO. OF CASES(n)	PERCENTAGE(n%)
ACL	38	76%
PCL	3	6%
MM	17	34%
LM	11	22%
MCL	14	28%
LCL	9	18%
BC	21	42%
Fractures	7	14%
Joint Effusion.	25	50%

MRI diagnosis was placed into one of the four categories after arthroscopic evaluation:

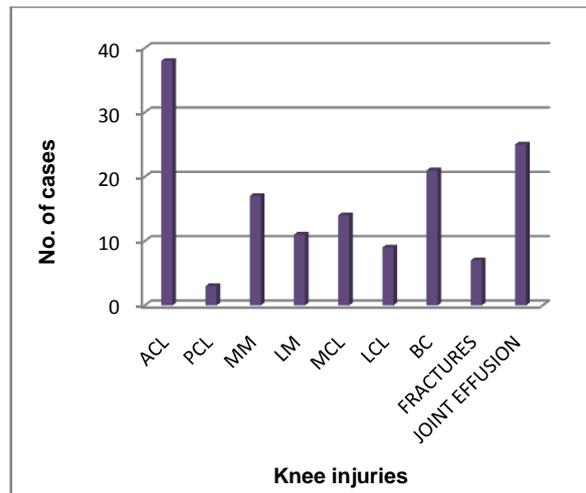
1. True positive: MRI diagnosis of tear, confirmed on arthroscopic evaluation
2. True negative: MRI diagnosis of no tear was confirmed on arthroscopy
3. False positive: MRI showed a tear but arthroscopy was negative
4. False negative: If MRI images were negative but arthroscopy showed a tear

Test	True positive	False positive	False negative	True negative
ACL MRI findings	35	2	1	12
PCL MRI findings	3	0	0	47
MM MRI findings	13	4	27	6
LM MRI findings	9	2	35	4

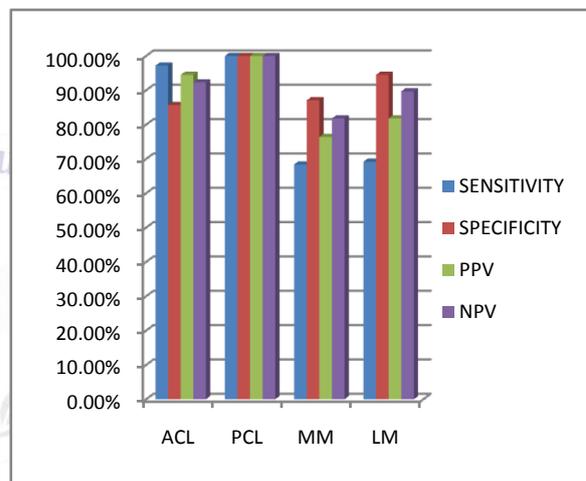
Based on the above categories, sensitivity, specificity, PPV, NPV were calculated to assess the reliability of the MRI results.

**Table 2: Accuracy of MRI findings using Arthroscopic findings as the reference data**

Tears	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL	94.59%	80.00%	94.50%	80.00%	94%
PCL	100%	100%	100%	100%	100%
MM	68.42%	86.66%	76.47%	81.20%	80%
LM	69.23%	94.10%	81.81%	88.88%	88%



**Fig 5: Bar diagram of various injuries in knee joint trauma in study population**



**Fig 6: Bar Diagram showing sensitivity, specificity, PPV & NPV of various ligament and meniscal injuries of knee joint in study population**

## DISCUSSION

Imaging of knee presents a special challenge because of its complex structure. A variety of imaging modalities are currently used to evaluate knee abnormalities. These modalities include standard radiography, scintigraphy, computed tomography, magnetic resonance imaging and arthrography. MR imaging has revolutionized knee imaging. It has been compared by various studies between magnetic resonance and arthroscopic findings. These studies validate the role of MR imaging in the clinical arena especially for the evaluation of knee injuries.

The study population consisted in the age group of 16 to 61 years. Maximum

number of patients who underwent MRI of the knee for injuries belonged to the age group of 18 to 28 years. Out of total 50 patients, ACL tear was most common finding affecting 38 patients (76%) among which 30(79%) had complete tear and 8 patients (21%) had partial tear, followed by Medial meniscus tear in 17 (34%) and lateral meniscus tear seen in 11 patients (22%). In a similar study by Singh et al., 45.08% showed ACL tear, among which 66.67% were partial and 21.13% were complete ACL tear. The authors concluded ACL tears to be more common than other ligamentous injuries. [8]

There was preponderance of MM over LM in our study which was again correlated with the study done by Singh et

al., [8] Out of 173 they found 57(32.9%) patients showed MM tear and 28 (16.1%) patients showed LM tear.

Sensitivity, specificity and accuracy of MRI in detecting ACL tear was reported to be 98.7%, 98.9% and 98.8% in a study by Singh et al., [9] Ha et al [10] reported the sensitivity, specificity and accuracy of MRI to detect ACL tears to be 96%, Sensitivity, specificity, accuracy of MRI in detecting ACL tear was reported to be 91.6%, 95.2% and 94.4% in a study by Yaqoob et al. [11] Sensitivity was 88.5 percent, specificity was 71.4 percent and positive and negative predictive values were 85.2 and 76.9 percent respectively in a study by Saurav et al [12] which are in concordance with our study.

Table 3: Comparison of ACL tears with other studies

	Singh JP et al IJRI 2004 (N=173)	Taryn PT et al AJR 170/MAY 1998 (N=217)	Present study (N=50)
Sensitivity	98.72%	96.00%	97.2%
specificity	98.94%	98.00%	85.7%

Lower specificity is because of suboptimal selection of imaging planes, and partial volume averaging effect

Table 4: Comparison of ligament and meniscal tears with other study

Type of injury	Present study (n=50)	Singh JP et al 2004 (n=173)
ACL	38(76%)	78(45.09%)
PCL	3(6%)	10(5.78%)
MM	17(34%)	57(32.95%)
LM	11(22%)	28(16.18%)
MCL	14(28%)	--
LCL	9(18%)	--

Singh J.P et al, IJRI 2004 studied on cruciate ligaments and menisci in twisting injuries. In the present study ACL tears are more because most of injuries are road traffic accidents.

PCL injuries are less common than ACL injuries and reported rates vary from 3% to 20%. The PCL being a stronger ligament has a low incidence of tears. The sensitivity, specificity and accuracy of MRI in identifying PCL tear is 100% which is similar to a study by Manoj et al [13] in which the accuracy of MRI in detecting PCL tears is 100%.

MRI of the knee has been found to be highly accurate in the diagnosis of meniscal tears. All the medial meniscal tears are associated with ACL tears in present study. The biomechanical forces that result in the ACL tear also result in medial meniscal tear. Because of multiple tear the sensitivity of the medial meniscal tear is reduced. Due to presence of multiple tears one peripherally located meniscal tear was over looked on MRI in two patients. The sensitivity of medial meniscal tear is reduced in the presence of ACL tears. [14] The medial meniscal tears are usually peripheral tears when associated with ACL tears

One patient interpreted as a medial meniscus tear on MRI was found to be normal at arthroscopy. That the posterior horn of the medial meniscus is an especially difficult area to visualize and the arthroscopic diagnosis of meniscal tears in this region is difficult. This misinterpreted medial meniscus tear was located in posterior horn. It could likely that this tear was missed on arthroscopy. One patient had peripheral vertical tear of medial meniscus

along with ACL tear and PCL tear was overlooked on MRI.

**Table 5: Comparison of MM tears of present study with other study**

	LukeP.Cheung MD et al RSNA 1997 (N-293)	Present study (N-50)
SENSITIVITY	89.00%	68.42%
SPECIFICITY	84.00%	86.66%

Lower sensitivity for MM tears in present study is because of associated multiple injuries

**Table 6: Comparison of LM tears of present study with other study**

	LukeP.Cheung MD et al RSNA 1997 (N-293)	Present study (N-50)
Sensitivity	72.00%	69.23%
Specificity	93.00%	94.10%

The sensitivity and specificity of present study are comparable with LukeP.Cheung MD et al RSNA 1997

The results of this study is in accordance to the literature which suggests an accuracy of 68 to 88 percent for the meniscal tears [15] and 80 to 94 percent for the cruciate ligament tears. [16]

## CONCLUSION

- Ligamentous and meniscal injuries occur frequently in patients with trauma to the knee. It is noted that ACL and MM are more commonly torn when compared to PCL and LM While ACL and MCL tears show predilection towards medial meniscus tear, LCL tear showed a strong relationship with lateral meniscus tear
- MRI is highly sensitive and accurate at identification of both anterior cruciate and posterior cruciate ligament tears. A close agreement was obtained between MRI and arthroscopic diagnosis. The diagnostic yield is increased with appropriate use of sequences and proper analysis of images in all planes.
- Misinterpretations are more likely to happen in the case of partial anterior cruciate ligament tear where it can be missed or it can be overdiagnosed on MRI
- Description of the type of ACL and PCL tears helped the orthopaedic surgeons as

a conservative approach was indicated in partial tears while a reconstruction was indicated in a complete tear

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## REFERENCES

1. George Y. E, Thomas A M, David S.T. MRI in the diagnosis of knee injuries. Iowa Orthop J. 1993; 13: 70–78. [PubMed]
2. Barber-Westin SD, Noyes FR. Objective criteria for return to athletics after anterior cruciate ligament reconstruction and subsequent reinjury rates: a systematic review. Phys Sports Med. 2011;39(3):100–10. [PubMed]
3. Claus Muhle, Joong Mo Ahn, Constanze Dieke. Diagnosis of ACL and meniscal injuries: MR imaging of knee flexion versus extension compared to arthroscopy. Springer Plus. 2013;2:213.
4. Mandelbaum BR, Finerman GAM, Reicher MA. Magnetic resonance imaging as a tool for evaluation of traumatic knee injuries. Am J Sports Med. 1986; 14:361.
5. DeSmet AA, Tuite MJ, Norris MA. MR diagnosis of meniscal tears: analysis of causes of errors. AJR. 1994;163:1419–23.
6. El-Khoury, G.Y., Kathol, M.H., Manning, T.A. et al. Magnetic resonance imaging in the diagnosis of knee injuries. Emergency Radiology (1994) 1 (3): 150-159. doi:10.1007/BF02614915
7. Harms, S.E., Flamig, D.P., Fisher, C.F., Fulmes J.M.: New Method for Fast MR Imaging of the Knee. Radiology, 1989;173:743.
8. Singh JP, Garg L, Shrimali R, Setia V, Gupta V. MR Imaging of knee with Arthroscopic Correlation in Twisting Injuries. Ind J Radio. 2004;14(1):33–40.
9. Singh JP, Garg L, Shrimali R, Setia V, Gupta V MR Imaging of knee with

- arthroscopic correlation in twisting injuries IJRI 2004;14;33-40.
10. Ha, King C.P. Taryn P, Li, Christopher F. Beaulieu, Gabrielle Bergman, Ian Y. Ch'en, David J. Eller, Luke P. Cheung Robert J. Herfkens, Anterior Cruciate Ligament Injury: Fast Spin Echo MR Imaging with Arthroscopic Correlation in 217 Examinations AJR 1998;170:1215-1219
  11. Yaqoob J, Alam MS, Khalid N. Diagnostic accuracy of Magnetic Resonance Imaging in assessment of Meniscal and ACL tear: Correlation with arthroscopy. Pak J Med Sci 2015;31(2):263-268.
  12. Saurav Singla, Nitin Kansal. Sensitivity and specificity of MRI versus arthroscopy in internal derangement of knee. International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013
  13. Manoj MK, Brijesh Ray RS, Jose Francis. Correlation between MRI and arthroscopic findings in injuries of knee joint. Kerala Journal of Orthopaedics Volume 27, Issue 1, January 2014
  14. Roberts C, Towers JD, Spanghel, Carrino J, Morisson W. Advanced MR imaging of the cruciate ligaments. Magnetic Resonance Imaging Clinics 2007;148:762-765
  15. Herman LJ, Beltran J: Pitfalls in MR imaging of the knee, Radiology 167:775, 1988.
  16. Tung GA, Davis LM, Wiggins ME, Fadale PD. Tears of the anterior cruciate ligament: Primary and secondary signs at MR imaging. Radiology, 1993; 188:661-7.

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